Form 1220–5
(January 1974)

Filing Code 6611

Date Issued February 1979

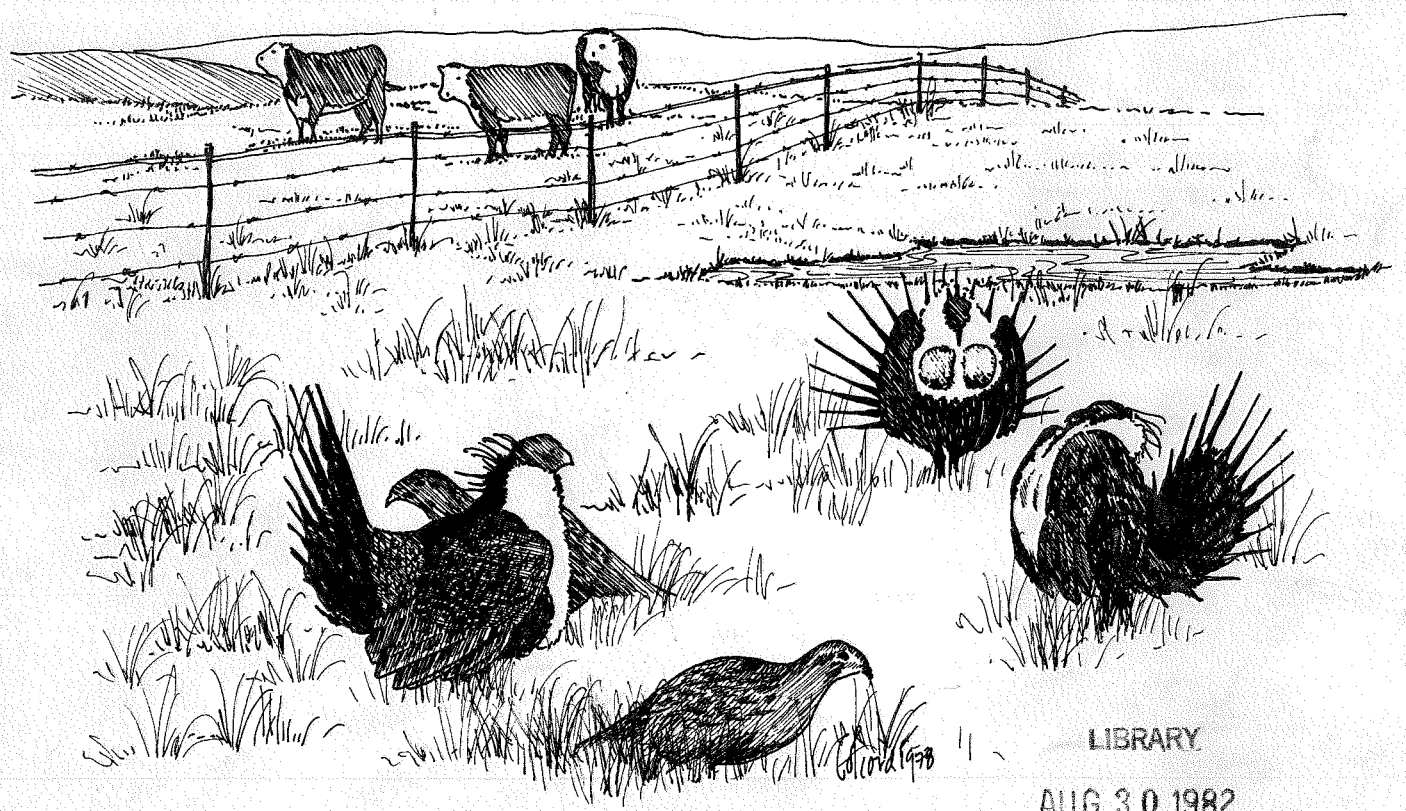
Technical Note 330

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

TECHNICAL NOTE

U.S. DEPARTMENT OF THE INTERIOR – BUREAU OF LAND MANAGEMENT

Habitat Requirements and Management Recommendations for Sage Grouse



Additional copies of Technical Notes are available from DSC, Federal Center Building 50, Denver, Colo., 80225

HABITAT REQUIREMENTS AND MANAGEMENT RECOMMENDATIONS FOR SAGE GROUSE

by

Mayo W. Call
Avian Biologist
Denver Service Center

Bureau of Land Management
U.S. Department of the Interior
Denver, Colorado

TABLE OF CONTENTS

INTRODUCTION

The future of the sage grouse (*Centrocercus urophasianus*), which occurs throughout most of the sagebrush-covered lands of the West, depends largely upon man's ability and willingness to maintain habitat vital to its needs. No other bird is so habitat specific to one particular plant type in meeting its annual life requirements. Patterson (1952) observed that sage grouse have continued to be specific in their habitat requirements in spite of changing land use patterns. He further affirmed, and most wildlife biologists agree, that sage grouse have not adjusted, and doubtlessly will not adjust their life processes to fit a pattern of land use which eliminates or seriously disturbs large tracts of the sagebrush-grassland types on any of their seasonal ranges. Overall, more than 90% of all sage grouse nests are located under or adjacent to sagebrush plants, and grouse feed almost exclusively on sagebrush leaves during the winter, hence, their reliance on this plant type.

While some areas of sagebrush may be too dry, lack suitable understory, are too dense or tall, or are otherwise inadequate in meeting some need of sage grouse in their annual life cycle, most western states except Arizona retain at least remnant populations of these birds. Arizona apparently has had no sage grouse in recent times and New Mexico has only a few remaining birds.

During the past 35 years many sagebrush-covered valleys and foothill ranges have been sprayed, plowed, chained, burned, disked, cut, or beat in an attempt to convert these ranges to grass lands. Schneegas (1967) estimated that 5 to 6 million acres of sagebrush had been treated in one way or another to reduce the sage component. Sage grouse populations have been drastically reduced in such areas. It was estimated by Martin, et al. (1951) that more than 50% of the original sage grouse habitat had been eliminated. While other authors have indicated lesser amounts of change, the total acreage involved in treatment has been enormous and has had significant adverse impacts on sage grouse populations throughout the West. Fortunately, many treated areas gradually develop a new brush component, and some grouse return.

This Technical Note is primarily a review of literature on the fundamental habitat requirements of sage grouse and habitat management methods that may be used to perpetuate the species. It does not reiterate the life history, past distribution, species characteristics, and population dynamics, all of which have been discussed in *THE SAGE GROUSE IN WYOMING* and other publications. Many of the pertinent publications are listed in the Literature Cited and are the primary sources from which the text of this publication has been derived.

Outlook

Alteration of sagebrush rangelands is still occurring but at a reduced level. Vale (1974) estimated that probably fewer than 50,000 acres per year were being treated at that time, and the author estimates that probably fewer than 30,000 acres per year are being treated at present. Reasons for reduced alteration of sagebrush habitats, especially on public lands, relate to questions concerning the effectiveness of such programs, economic returns, requirements of the National Environmental Policy Act, and concern about the wildlife using sagebrush lands. Many wildlife species, other than sage grouse, are largely habitat specific to sagebrush, including sage thrashers, sage sparrows, Brewer's sparrows, and several small mammals and reptiles. While spraying of sagebrush on public lands using 2,4-D has virtually stopped, it is possible that use of this chemical may be proposed again for range "improvements" under the Public Rangelands Improvement Act. However, with today's prevailing environmental philosophies, greater consideration by Federal agencies of wildlife and all environmental aspects in proposed project areas will be required before any treatments are applied.

BACKGROUND

Distribution

It is not possible to consider the distribution and habitat requirements of sage grouse without first considering the distribution and status of big sagebrush (*A. tridentata*), because this grouse is intimately and inseparably associated with this specific plant group (Rogers 1964). No other bird is more closely tied to a specific plant type for both food and cover.

In pristine times sage grouse were found throughout the range of big sagebrush. At present, sage grouse occupy most of their historic range in reduced numbers and have disappeared mainly from areas on the periphery of former ranges where extensive areas of sagebrush have been removed (Bureau of Land Management 1970). Sage grouse distribution is not continuous throughout the West because of the interspersion of forested mountainous areas, although mountains are apparently no barrier to the dispersal or movement of these birds within their natural range. Historically, as today, sage grouse were most commonly encountered *near the mountains*. High plateaus and intermountain valleys continue to provide the best conditions for the continued survival of sage grouse populations (Patterson 1952). In spite of the great reduction in habitat which resulted from the settlement and development of western United States and Canada, the geographical distribution of the species has remained relatively unchanged. Although there has been a reduction in numbers of sage grouse which accompanied major changes in the pattern of land use, they have apparently been extirpated only in British Columbia, so far as their historical range is concerned. A good discussion of history and status on a state by state basis is presented in *The Sage Grouse in Wyoming* (Patterson 1952). The present range of sage grouse is shown in Figure 1.

Reasons for Habitat Loss

All of the areas listed by Cary (1911) and others still contain some sagebrush but, due to advancing civilization many could not now be considered as a sagebrush type. Overgrazing, irrigation projects, dry farming, reseeding, and miscellaneous factors have all played a part in changing or modifying original sagebrush lands (Rogers 1964). Patterson (1952) stated, "Since the intrepid John Colter made his explorations over the western plains and mountains, the fur trapper, settler, railroader, stockman, reclamationist, and industrialist have in succession been lured onto western rangelands, each attempting to improve on the system of land use and the pattern of life, long practiced by the Indian, wildlife, and nature."

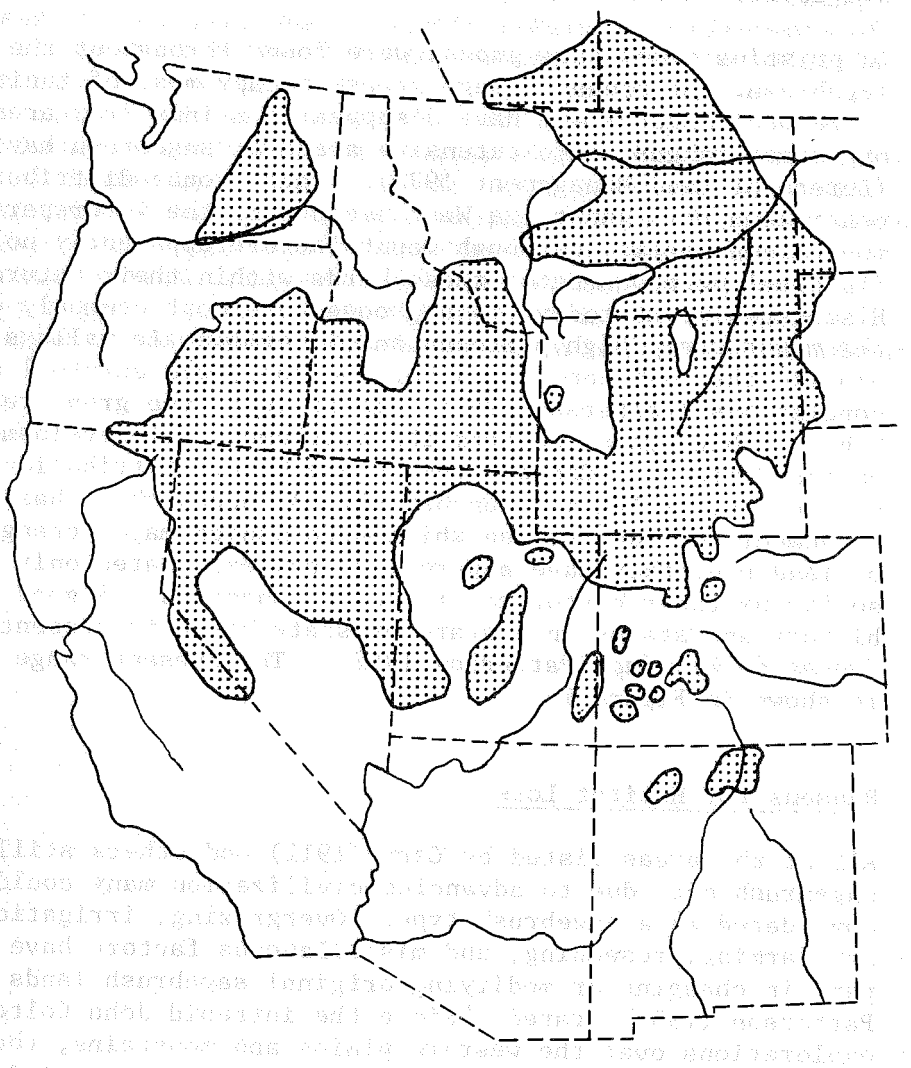


Fig. 1. Sage grouse distribution in North America -- 1975 (Wallestad 1975).

Decrease in sage grouse numbers directly followed the decrease in sagebrush range. The history of early land-use programs made the decline of native wildlife populations almost inevitable. The pattern of decline in sage grouse numbers has been little different from that exhibited by numerous other game animals in the West. Destruction of habitat has been the basic cause of sage grouse decrease throughout the West. The decimating factors usually have operated through the overgrazing of public and private ranges, as well as elimination of sagebrush through agricultural practices and urban development. The oft mentioned decimating factors of unfavorable weather, increased predation, hunting and disease may have been of significance in localized areas, but were relatively *unimportant* in the overall decline in sage grouse numbers. *The major factor in the past, as well as the present, that most adversely affects wildlife populations . . . . is the loss in quality or quantity of suitable habitat.* Overgrazing of public and private rangelands by domestic livestock apparently reached a peak in the early 1900's and, although somewhat reduced, still remains a problem on some ranges.

Some of the changes that resulted from livestock grazing, agricultural practices, and other land uses probably benefitted sage grouse. The creation of openings in large sagebrush stands, from whatever cause, may create feeding and brooding areas for grouse and may be beneficial if water is close. The addition of meadows has added to their food supply. Where burning, chaining, or other land use practices have removed stands of large, decadent sagebrush and permitted the development of new, young sagebrush stands, the habitat for sage grouse has probably been improved. In a later discussion on habitat requirements the results of such practices will be considered in greater detail.

In areas where human populations and agricultural developments are expanding, it can be expected that sage grouse numbers will decrease mainly from elimination of their habitat. There seems to be a striking correlation between sage grouse abundance in the various western states and corresponding human populations. It is not mere coincidence that the states supporting the lowest human population densities contain the greatest acreages of sagebrush habitat and the largest sage grouse populations (Patterson 1952).

Many diverse land use activities are now occurring on the public lands, with a seeming increase in tempo occurring each year. New power plants are rising from once quiet sagebrush valleys; where Brewer's sparrows and sage grouse once nested the soil and vegetation is now gone, having been swallowed up and regurgitated by huge earth-moving vehicles in stripping the land for coal mining operations; and new oil and gas exploration and/or development operations are scattered across the

landscape where only antelope, ferruginous hawks, and other wild creatures were to be seen only a few years ago. Some of these developments cause permanent loss of sage grouse and other wildlife habitat, while others cause only temporary losses or slight disturbance. An oil well may produce only short-term disturbance during the drilling operation and little significant loss of habitat during pumping operations, while strip mining and power plant installations are long-term losses of habitat. With the latter two developments, there also comes increasing encroachment on the surrounding land with the influx of people required to operate the facilities. The actual disturbance created by land use activities varies, partly due to the amount of disturbance to which wildlife has become accustomed. For example, one study in the Green River Basin of Wyoming on the effects of an oil drilling operation revealed that the drilling operations *had not interfered* seriously with sage grouse nesting and strutting activities. The birds continued to occupy areas adjacent to the well site throughout the drilling period, even to the extent of nesting within a few hundred yards of the rig, strutting within 50 yards of the operations, and watering daily at sediment pools located at the base of the rig (Patterson 1952). Unfortunately, long-term impacts were not measured.

In primitive times sage grouse populations attained their greatest abundance in the mountain foothills and along the fertile sagebrush-covered flats bordering mountain streams. Accompanying the various land uses there has been a maximum utilization of surface water supplies for irrigation and other domestic purposes. Entire streams have sometimes been diverted from their channels with the resultant drying of stream beds. In many other instances the application of water to lands unsuitable for cultivation has resulted in severe leaching of alkali salts with resultant pollution of stream courses and conversion of fertile sagebrush lands into alkali-impregnated tracts featuring salt shrubs.

Agricultural development, livestock grazing, and wheat-farming activities have been largely responsible for the elimination of sage grouse ranges along valley foothills and lower river drainages. The elimination of this habitat frequently has little effect upon the spring and summer activities of sage grouse, but it sometimes completely destroys vital winter ranges. The species is mobile, occasionally migrating from higher mountain ranges where they spend their summer to ranges several thousand feet lower where they find adequate available sagebrush to survive the winter. In some areas these winter ranges have been almost completely eliminated and replaced with agricultural crops, resulting in the loss of the dependent sage grouse populations.

Federal Policies

White man has waged war against sagebrush since the first settlers carved farms from the native prairies. The wide adaptability of sagebrush for survival under varying conditions of climate gave rise to the widespread belief that it is a noxious plant with low forage values and should be eliminated throughout large areas of the West. According to range experts' comments in the 1948 Development of Agriculture Yearbook, sagebrush is considered to be of low forage value to livestock and is seldom browsed by sheep unless other forage is scarce or covered with snow. They considered the more palatable plants to be waning on the desert winter ranges and that sagebrush was invading the foothill ranges. Price (1948) stated that on range areas occupied by low value or noxious range plants such as mesquite (*Prosopis juliflora*) and sagebrush, full returns from proper stocking, improved management and reseeding would not be possible until such soil-moisture "robbers" were eradicated, or at least controlled. The Bureau of Reclamation has also gone to great length over the years to put across the idea that western sagebrush lands were worthless unless reclaimed for agricultural purposes. Bureau press releases often carried such statements as "irrigation waters have been diverted onto hundreds of thousands of acres which once grew nothing more valuable than sagebrush."

Federal agencies, such as the Bureau of Land Management and the Forest Service, were active for many years in eradicating sagebrush. Methods included controlled burning, application of chemicals, and removal by means of mechanical implements. The sagebrush eradication program has gained prominence in the livestock economy as a result of several factors. In cooperation with state agricultural extension services and various implement companies, the U.S. Soil Conservation Service has actively supported an extensive sagebrush removal program in the Intermountain Region (Patterson 1952). According to the Soil Conservation Service, millions of acres of rangeland in the Intermountain area have offered farmers and ranchers only 10 to 50% of the range feed that they are capable of producing. The Soil Conservation Service has advised ranchers to clear sagebrush lands and seed to crested wheatgrass and other grasses to improve their livestock yields and to gain a more effective control of erosion (Miles 1946). Also, the agricultural conservation program of the Production and Marketing Administration, U.S. Department of Agriculture, contained provisions for making substantial payments to private landowners in return for clearing sagebrush and planting the land to pasture grasses or crops.

To a large degree, sagebrush eradication programs by BLM, the Forest Service, and other Federal agencies were carried out in total disregard, and perhaps ignorance, of the tremendous value of browse plants to the welfare of livestock and wildlife. Any land use practice which has as its objective the permanent elimination of sagebrush and establishment of grasses in the Mountain West will ultimately reduce the collective carrying capacity of that range for livestock (especially sheep), elk, mule deer, antelope, sage grouse, and many smaller species of wildlife.

Public concern for all forms of wildlife has increased greatly during the past 10 years and the public now demands that Federal agencies give greater thought to wildlife and the general environment in any proposed projects that could produce serious adverse impacts. It is fortunate for wildlife that several Acts have been passed in recent years that provide better protection both to the animals and their habitats. Unfortunately, this is not true for actions taking place on private lands where profit motives continue to dominate over possible reduction of local wildlife populations or damage to the existing ecosystem.

The Federal Land Policy and Management Act of 1976 gives greater impetus to the Bureau of Land Management for proper consideration and management of *all* resources on the public lands. Under this Act, wildlife is considered a *major* resource value. The Public Rangelands Improvement Act of 1978 authorizes millions of dollars over the next 20 years for measures to make grazing lands more productive and affects some 150 million acres under BLM administration. This rangeland improvement *must* include benefits for wildlife, as well as range improvements for domestic livestock production and general improvement of the range.

In spite of past recommendations and opinions of administrators of various governmental agencies regarding sagebrush, the plant is still considered by many wildlife biologists to be the most valuable food and cover plant for wildlife on ranges of the Intermountain Region. With today's philosophies on the values of the many varied resources on public lands, it is unlikely that large sagebrush control projects will continue to eradicate sagebrush on public lands as they have in the past. For example, in the 1950's it was discovered that sagebrush could be effectively killed with aerial applications of the herbicide, 2,4-D. Elimination or reduction of sagebrush to increase grass production became a common practice on public and private rangelands by the early 1960's. By the time wildlife agencies realized the seriousness of this new tool, as a threat to wildlife habitat, several *million* acres had been sprayed, and many more projects were in the planning stage. In

1965 the Bureau of Land Management, in cooperation with the Montana Department of Fish and Game initiated a 10-year study to determine the ecological effects of sagebrush control on associated plants and animals. Results of this research were published in the bulletin prepared by Wallestad (1975) entitled *Life History and Habitat Requirements of Sage Grouse in Central Montana*. It is expected that all Federal agencies will give due consideration to research findings such as those in the Montana publication in all future proposed land use activites and vegetation changes.

HABITAT REQUIREMENTS

General Requirements

Physiographic

Sagebrush-grass ranges cover approximately 90 million acres, most of which are in relatively dry valleys and intermountain basins. Elevations in this type range chiefly between 2,000 feet in central Washington to over 8,000 feet in Colorado. Sage grouse are most frequently found in flatland or on gently rolling hills.

Climatic

Mean annual precipitation on the sagebrush-grassland ranges varies from about 5 inches in the deserts to about 30 inches in some mountain foothills. A few sage grouse may be found in salt-desert shrub ranges where precipitation varies from 5 to 10 inches yearly. Such ranges are marginal for grouse. Where sage grouse occur in the salt-desert shrub type, *Artemisia spp.* are the most important plants of the habitat. The primary factor involved with sage grouse is that precipitation be adequate to provide for succulent forbs and grasses amongst or near their sagebrush habitat.

Sage grouse inhabit the semi-arid plains of the western United States which experience varied and extreme climatic conditions. Severe weather conditions (unless snow completely covers the sagebrush) have little effect on the birds. The success or failure of sage grouse in a particular year has often been attributed to weather conditions during hatching, with cold, rainy weather conditions usually blamed for poor productivity. To determine the effects of weather on sage grouse, Wallestad and Watts (1973) analyzed 10 years of sage grouse production data from central Montana to isolate factors affecting productivity. Their findings are as follows:

1. No correlation existed between productivity and rainfall during the hatching period.

2. An inverse correlation existed between productivity and rainfall during the egg-laying period. Heavy rain (greater than 1 inch) during the egg-laying period caused a late hatch resulting in poor productivity.

3. Snow melt, temperature, and precipitation, as they potentially affected spring greenup of vegetation, further explained variations in productivity. Even if rainfall was optimum during the egg-laying period, production would be poor if total spring precipitation during the growing season was inadequate for necessary plant growth (less than 3 inches from mid-April through mid-June).

4. No correlations existed between temperature and grouse productivity.

5. Adult sage grouse (average 78%) were predictably more successful than yearlings (average 62%) in bringing off a brood.

6. On the basis of numbers, the yearling female was the single most important age class producing young. Therefore, years of poor productivity occurred because of factors working primarily against the yearling segment of the population.

Water

In primitive times, water was probably a key factor governing the distribution and relative abundance of sage grouse populations. It is equally important now, although water developments are frequently a feature of agricultural and rangeland improvement programs and irrigation projects. While these programs have occasionally improved sage grouse habitat locally, they have frequently caused a drastic reduction in sage grouse numbers as the result of vast acreages of sagebrush destroyed to accommodate the new land-uses.

Free water is considered by many to be a key component of sage grouse habitat. During summer months sage grouse are *normally* limited in their *desert* distribution to the immediate vicinities of stream courses, isolated desert springs, and water holes. During summer and fall, if free water is available, sage grouse normally make a morning and evening visit for purposes of drinking. They have also been observed to regularly visit partially frozen streams in Eden Valley in Wyoming during the late fall months in order to drink through holes in the ice. Many ranchers relate stories of sage grouse flocks coming into their ranch yards and drinking from livestock watering troughs. Although sage grouse apparently do not require open water for their day to day survival, they do utilize it when available, and attain their highest population densities in those areas which contain abundant and well-distributed surface water supplies. In small mountain valleys and along mountain foothills where precipitation has stimulated the development of succulent forbs and grasses, grouse may obtain adequate moisture from the vegetation.

Since moisture in the form of open water, dew, and rain water is not regularly available on desert ranges, their moisture requirements may be fulfilled partially through the medium of metabolic processes within the bird itself. In any case, while free water may not be a limiting factor to these birds, they are normally found within a mile or two of free water which they frequently utilize. In winter, snow takes care of their moisture requirements, either directly or as it melts and provides free water on warm days.

Precipitation distribution, amounts, and seasonal occurrence, all affect sage grouse distribution to some extent. Where late spring and early summer precipitation is abundant and widespread, the development of succulent vegetation usually induces a wider distribution of grouse, whereas in drought years they congregate in areas where free water is available.

Vegetation

In considering the habitat requirements of sage grouse the manager must consider the various seasonal needs of the birds and the large areas usually involved in their annual cycle. Deep snow may cover the spring and summer ranges forcing the birds to migrate to some distant area for winter and to return for nesting as snow depths decrease. Where grouse nest and raise their broods on sage-covered slopes or in mountain valleys at high elevations, they usually must migrate to the desert floors or other low elevations to find exposed sagebrush for food during the winter. In many areas, summer and winter areas may be as much as 20 or more miles apart.

Vegetation structure and composition on strutting grounds will be different than the vegetation complex on wintering areas or in nesting areas. Dense, tall sagebrush is seldom used for nesting cover but is frequently used as loafing cover or as protective cover during severe winter storms. Rogers (1964) stated that, in general, good sage grouse habitat should contain openings less than 300 yards in circumference, some dense stands, and about equal amounts of tall and short sagebrush plants. In the following discussion, the various habitat components required to fill the needs of the birds during various phases of their life cycle are presented.

Specific Requirements

Breeding Habitat

For courtship and mating, sage grouse assemble during the breeding season in groups on strutting grounds. Barring complete obliteration of the physical aspects of the strutting area itself, generation after generation of birds will utilize the same parcel of land for breeding. The duration of occupancy of individual grounds usually extends over many years, although in the interim, new grounds are created by young birds, and others probably are passing out of existence due to the disintegration of a localized male population (Patterson 1952).

Wallestad and Schladweiler (1974) recorded sagebrush height and canopy coverage at 110 daytime feeding and loafing sites of cocks. Eighty percent of the locations occurred in sagebrush with a canopy coverage of 20-50%. Unfortunately this is also the range of canopy coverage in which vegetal control is most likely to occur.

Strutting grounds (leks) may be located at a point intermediate between the winter range and summer range, or in some cases the summer and winter range may be the same area. The grounds are usually small open areas from 1/10 to 10 acres in size, but may be as large as 100 acres or more. Snow conditions play a part in the suitability of an area for strutting as does the amount of vegetation. The strutting ground is an area supporting low, sparse sagebrush or else an area denuded of vegetation. Grassy swales, natural and irrigated meadows where grass has been removed, burned areas, cultivated fields adjacent to sagebrush-grass rangelands, cleared roadsides, abandoned homesteads, dry lake beds, etc., serve for this purpose often with seemingly little attention paid to other land uses. (Bean 1941, Carhart 1941, Patterson 1952, Dalke et al. 1963.) *Strutting grounds are often located near water.* Fig. 2 shows a strutting ground in southwestern Utah.

Studies show there may be a gradual shift in strutting ground locations over a long period. Also, a shift in use of grounds, small grounds being abandoned and larger grounds increasing in use, may occur toward the end of the breeding season (Dalke et al. 1960).

Because of the utilization of strutting grounds, sage grouse *population estimates* can be made by counting the total number of grouse using all grounds during the mating season. *Population trends* can be estimated by counting the birds on all strutting grounds in an area for a period of several years. Because of some movement of birds between grounds in any given year, and some shift from adult males to juveniles on the grounds towards the end of the breeding season, some interpolation of counts must be provided. Sage grouse in most states have begun courtship behavior on strutting grounds by mid-March. Methods for counting grouse on

Fig. 2. Strutting grounds are usually in open areas or areas of relatively low vegetation. This one is in southwestern Utah.

Fig. 3. Nesting habitat in an area of low, scattered sagebrush in central Wyoming. The hen in the center moved off her nest which is just outside the lower left margin of the photograph.

strutting grounds are provided in *Sage Grouse Investigations in Colorado*, *The Sage Grouse in Wyoming*, and others. Sage grouse, as a rule, pay little attention to a vehicle driven close to, or even into, their strutting area. Therefore, it is desirable for all strutting counts to be made from inside a vehicle.

Nesting Habitat and Nests

Sagebrush forms the nesting cover for most sage grouse nests throughout the West with concealment being the basic requirement of nesting cover. In Wyoming 92% of approximately 300 nests found by Patterson (1952) were under sagebrush. Additional nests found under sagebrush included 92% of 117 nests found in Colorado by Gill (1965); 50 nests found by Girard (1937) in Wyoming; 94% of the nests located by Keller et al. (1941) in Colorado; 35 nests found by Gray (1967) in Idaho; and all 41 nests located in Montana by Wallestad and Pyrah (1974). Other researchers have recorded the same general findings. Fig. 3 shows a nest site in central Wyoming.

Rabbitbrush is occasionally utilized for nesting cover with greasewood and shadscale being rarely used (Patterson 1952). Use of other species of shrubs for nesting is rare. Hens nest in short sagebrush of medium density, such as is found on drier sites, in preference to the dense, tall brush found along watercourses and on moist areas. The individual nest site invariably provides for a quick and unimpeded escape for the hen if she is flushed unexpectedly.

Patterson (1952) found 8 nests located on bare ground *between* sagebrush clumps with no cover of any type over the nest sites. One such nest was placed between scattered tumbleweeds. Such nests are unusual.

Height of sagebrush commonly used for nesting varies between 7 and 31 inches (17 to 79 cm) with most nests located under the tallest bushes available at a particular site (Keller et al. 1941, Patterson 1952, Trueblood 1954, Gray 1967, Klebenow 1969, Wallestad and Pyrah 1974). Stands of 20-40% canopy coverage were most frequently selected for nesting. Wallestad and Pyrah (1974) compared the sagebrush characteristics around 31 successful and 10 unsuccessful nests. Successful nests had greater sagebrush cover within 24 inches of the nest and were located in stands of sagebrush with a higher average canopy coverage (27%) than those of unsuccessful nests (20%). Patterson (1952) measured height of nesting cover in Wyoming and reported that 216 of 262 nests measured had nesting cover between 10 and 20 inches tall. In Montana, Wallestad (1975) stated that average sagebrush height over nests was 15.9 inches. Unfortunately, most studies do not give the average sagebrush height that predominates in the area.

Nest sites are usually located within 2 miles of a strutting ground. Results of research by Wallestad and Pyrah (1974) showed that 68% of all

radio marked hens nested within 1.5 miles of a strutting ground, with the greatest distance nesting occurred from a strutting ground for one radioed hen being 5.7 miles. In Colorado, Rogers (1964) *reported* an unusual situation where hens traveled from 15 to 20 miles from the strutting ground to nest. Hens would visit strutting grounds until bred and then moved into a vicinity close to the location of the final nest site, and remained relatively sedentary until they nested.

Sage grouse nests are made by scratching out a shallow depression, usually beneath or between sagebrush plants, and then lined with dead grass, sage twigs, and feathers (Wallestad 1975). Egg laying normally begins about mid-April but a few renesting hens do not complete their clutches until mid-May.

Incubation takes about 25 to 27 days with the peak of hatching varying in different states between the last week in May to the second week in June. Average clutch size is 6 to 8 eggs, with a few nests containing up to 12 eggs.

Brooding Habitat

Broods need appropriate food in addition to cover. Their diet is chiefly insects early in life, shifting to succulent forbs and shrub foliage as they develop (Patterson 1952, Klebenow and Gray 1968, Savage 1968). The succulence of their favored foods appears to be a key factor in their movements. Favored foods are common dandelion (*Taraxacum officinale*), common salsify (*Tragopogon dubius*), western yarrow (*Archillea millifolium*) and others (Klebenow and Gray 1968, Savage 1968, Peterson 1970). Hens and chicks will usually remain in the vicinity of the nests for the first 2 or 3 weeks after hatching if insects and succulent forbs are available. As food plants mature and dry, the grouse move to areas still supporting succulent vegetation. These may be lower elevation native meadows or irrigated meadows when no uplands with green vegetation are in the area (Eng 1952, Rogers 1964) or they migrate upward, seeking out habitats where succulent forbs are still available such as more mesic swales (Klebenow 1972). Roadsides and borrow pits are frequently used during June and July because of moisture and succulent vegetation present. A delay in maturing of forbs has a noticeable effect on bird movements. Savage (1968) noted that on one study site where the range was in good condition, grouse did not use the meadows one summer, apparently because moisture was adequate in the outside areas to keep succulent forbs available.

Food is important, but all studies emphasize the need for cover. The usual case, however, is that the birds *appear to prefer relatively open sagebrush vegetation* types as compared to dense stands of sagebrush (Klebenow 1972). In southern Idaho the percent canopy cover of big sagebrush at brood sites

was 8.5, significantly less than the average for the entire area, 14.3. Three out of 98 broods were found where total shrub cover was 40 to 49%; the rest where cover was less than 31%. Where there was an interspersion of openings mixed with dense sagebrush, they used the more open portions (Klebenow 1972). Wallestad (1971) also reported that large tracts of dense sagebrush appeared to be undesirable brood habitat.

In late August at high elevations, or in September or October in some lower areas, the meadows dry and the incidence of frost increases, leading to drying or killing of the foliage of forbs. The incidence of sagebrush consumption increases at that time (Klebenow 1972). Increased moisture content may make sagebrush more palatable than during summer.

Brood hens do not usually associate with other hens and broods early in summer. As important food plants desiccate on upland sagebrush ranges, broods move to lower, more mesic sites, and associate with other broods. Late summer hen flocks vary in size from several broods to several hundred sage grouse. These associations may be the initiation of fall and winter hen flocks (Wallestad 1975).

In Montana, approximately 65% of all grouse observations during August and September were recorded in bottomland types such as alfalfa fields and greasewood bottoms (Wallestad, 1975).

While large tracts of *dense* sagebrush appear to have limited value as sage grouse nesting or brooding habitat, sagebrush stands of moderate densities are an essential part of sage grouse brood habitat, particularly during early and late summer. Figures 4 through 7 are examples of nesting and summer habitats.

Wintering Habitat

Sage grouse live almost exclusively on the leaves of sagebrush during the winter. In Montana when snow depth exceeded 12 inches, sage grouse were restricted to taller sagebrush stands, a relatively small percentage of the total range available to them in a normal (lesser snow) winter. Bean (1941) reported that when snow depth reached 13 to 15 inches in Idaho, sage grouse moved to taller sagebrush types. Eng and Schladweiler (1972) described winter ranges in eastern Montana as being large expanses of dense (20% or greater canopy coverage) sagebrush with an average height of 10 inches on land having little if any slope. This association with dense stands of sagebrush usually began in September (Wallestad 1971) and continued through the breeding and nesting seasons (Wallestad and Schladweiler 1974). Wallestad (1975) reported that 78% of 151 winter locations of radioed sage grouse occurred in the greater than 20% canopy coverage class. As weather moderated in February, activities shifted to more open stands of sagebrush.

Fig. 4. Good habitat for sage grouse showing excellent understory vegetation in a fairly sparse stand of sagebrush.

Fig. 5. Good nesting habitat for sage grouse in northeastern Utah. Springs and small streams are common throughout the area.

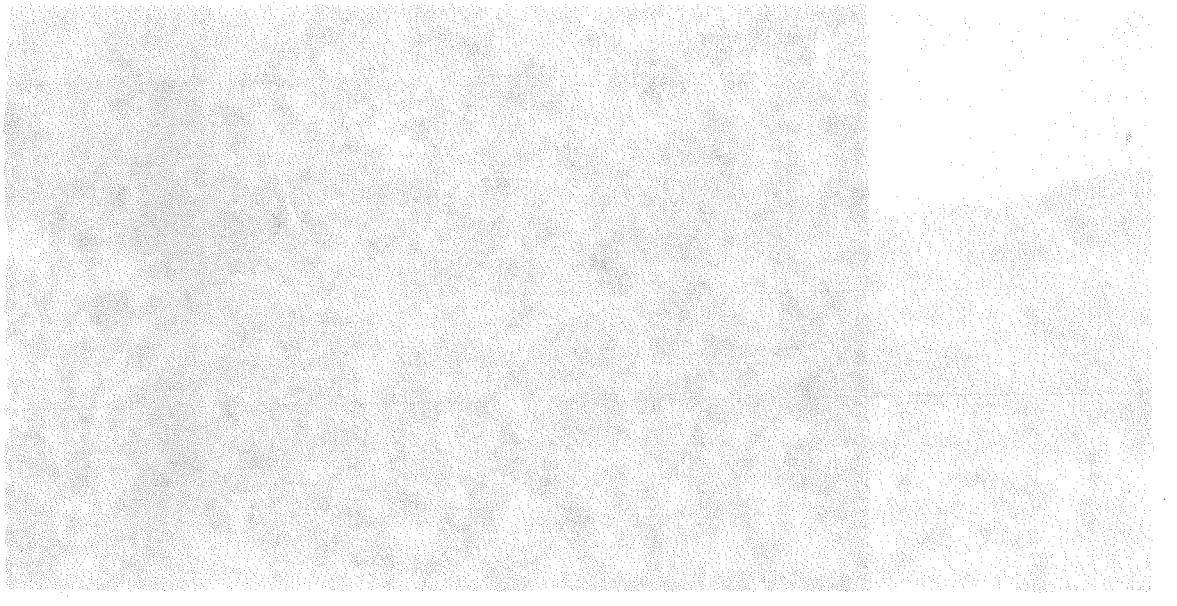
Fig. 6. Sage grouse nest in central Wyoming placed in low sagebrush and grass. Two young grouse have just hatched.

Fig. 7. An excellent brood use area with an abundance of dandelions and other forbs adjacent to surrounding sagebrush cover. An adult hen and a juvenile are present.

Wintering birds respond to snow. Snow depth forces the birds to lower elevations and appears to be a factor determining the actual wintering site for a flock (Klebenow 1972). Deep snow limits the availability of food. Black sage (*Artemisia nova*) was preferred as forage in southeastern Idaho. Sage grouse remain on the areas supporting this species until the snow covers the plants and return again when the black sage is available (Pyrah 1954, Crawford 1960). Biologists and field personnel report a similar preference for low sagebrush on Nevada and Utah ranges where it is available. In North Park, Colorado Beck and Braun (1978) reported that sage grouse wintered primarily on southwest exposures and on flat to gentle slopes.

Winter is normally the most critical period of the year for most wildlife and the most taxing upon their physiological systems. However, if *adequate* sagebrush is *available* to sage grouse, they normally come out of the winter months in fine physical condition, fully conditioned for an arduous three-month courtship and reproductive season. In fact, Beck and Braun (1978) found that yearling and adult males and females gained weight during late winter (January-March) in North Park, Colorado.

In some areas, sage grouse occupy windswept sagebrush ridges in winter. Patterson (1952) attributed the reduction in sage grouse numbers in intensively farmed areas along lower river drainages to the elimination of sagebrush which served as their winter range. Some wintering areas are arid regions that would be hot and untenable for grouse in summer.



DISTURBANCE FACTORS

Sagebrush Control/Modification

The greatest adverse influence on sage grouse is the destruction or adverse modification of their habitat. Sagebrush control may not have an immediate noticeable effect on a sage grouse population, depending upon the *size of the area treated* in relation to *total habitat available*. Rogers (1964) reported that a spray project which treated 1,700 acres of sagebrush in western Colorado apparently had little effect on the sage grouse population using the area. However, two years later an additional 1,300 acres were treated and he reported that the entire sage grouse population appeared to emigrate from the area. Data to support this conclusion are lacking.

The effects of sagebrush removal and/or modification on a population of sage grouse can be evaluated in three basic ways: (1) presence or absence and relative use by birds of treated areas as indicated by dropping counts, (2) changes in population levels as indicated by numbers of strutting males (if higher counts are not found on other strutting grounds in the area), and (3) direct observation of birds on and around the treated areas (Wallestad 1975).

Effects on Breeding Activities

Wallestad (1975) reported that a 31% loss of habitat adjacent to a strutting ground (lek) coincided with a 63% decline of strutting males in Montana. Peterson (1970), also in Montana, noted a lek which had averaged 54 males (for 13 years) dropped to 3 within 2 years following spraying and since has been totally abandoned. Higby (1969) reported that a 12,000 acre sagebrush spray project in Wyoming was responsible for the elimination of sage grouse from a winter range that supported 1,000 sage grouse prior to treatment. Four strutting grounds on the treatment area declined from a total population of 50 to 0 four years after treatment with 2,4-D. *Eight years* following treatment the grounds had partially recovered to a total of 31 males. Adjacent grounds in unsprayed areas had only minor fluctuations in bird numbers during this same period.

Peterson's (1970) report is one of the best documented instances of the detrimental effects of sagebrush removal on sage grouse. In an isolated sage grouse population in Meagher County, Montana he noted that a 49% decrease (11,808 acres) in sagebrush types, as a result of sagebrush spraying and conversion to cropland, eliminated 5 strutting grounds. Enyeart (1956) found that reseeding around leks in Utah caused sage grouse to abandon the areas or to terminate breeding activities at an earlier date than on undisturbed habitat. In Idaho, Autenrieth (1969) stated that a lek in a sprayed area will continue to be used if the surrounding nesting and brood rearing habitat has not been made uninhabitable by the removal of sagebrush and forbs.

In a cooperative research project between the Bureau of Land Management and the Montana Fish and Game Department and published as *Life History and Habitat Requirements of Sage Grouse in Central Montana*, Wallestad (1975) reported as follows (pp. 37-39):

> "Treatment of 751 acres (24% of the total suitable habitat adjacent to the King Ranch Strutting Ground) resulted in a 50% reduction in cocks the following year. However, 3 years post-treatment the population had recovered to pre-treatment levels. Spraying of 640 acres (11% reduction in suitable habitat) resulted in no significant post-treatment population change on the adjacent South Pike Creek Strutting Ground. A new ground (possibly because of spraying) was established 1.5 miles to the northeast, the year following treatment. Two hundred fifty-three acres adjacent to the Highway Strutting Ground was scheduled for a partial kill of sagebrush (65% reduction in crown coverage); however, the small size of the area, combined with a light actual kill (25% reduction in coverage) produced no major effect on the strutting ground cock population.
>
> "Of the 1,090 acres of sagebrush sprayed adjacent to the North Yellow Water Strutting Ground, 839 (31% of the total suitable habitat) had a canopy coverage exceeding 15% prior to treatment. The sprayed area was also the largest block of continuous habitat in the area. In the two post-treatment years there was a 63% loss in cocks on the strutting ground while other grounds in the Triangle remained relatively stable.
>
> "Total numbers of male sage grouse on 3 grounds within 0.5 mile of treated area increased an average of 28% from pre- to post-treatment years. In the face of an increasing population it appeared that sagebrush treatment had no effect on the sage grouse population. However, when compared to control grounds in the same population the effect becomes more pronounced. Total numbers of males on 2 grounds further than 2 miles from treated areas increased an average of 323% during the same period. *Number of sage grouse observed on grounds within 0.5 mile of treated areas and those further than 2 miles led to the conclusion that differences were related to sagebrush spraying.*" (Italics added.)

Effects on Nesting Habitat

In Idaho, Klebenow (1970) noted the cessation of nesting on newly sprayed

areas with less than 5% live sagebrush canopy cover, and observed that nesting was nearly non-existent in older sprayed areas with around 5% live sagebrush cover. Broods were less affected by herbicide treatment and continued to use some sprayed areas.

Effects on Brooding and Summer Habitat

In southwestern Montana, Martin (1970) studied the distribution of sage grouse broods in relation to a 1900-acre allotment that had been strip sprayed. Differential use of the sprayed and unsprayed sagebrush in that area was demonstrated by the fact that, although the area of sprayed strips was approximately 9 times that of unsprayed strips, the sprayed area provided only 4% of the 415 sage grouse observations. Rogers (1964) reported that an entire population of sage grouse appeared to emigrate from a 3,000 acre area in Colorado following several years of extensive spraying. In Idaho, Autenrieth (1969) conducted a 3-year study after a 1965 spray project and concluded that strip spray in a relatively high precipitation area (13 in. annual precipitation) benefited brood rearing habitat due to a quick recovery of important forbs such as dandelion (*Taraxacum spp.*) and western yarrow (*Achillea lanulosa*). After 3 years the average coverage of dandelions in the spray strips was 17.2% as compared with 11.2% in the leave strips. The leave strips were utilized by broods for feeding and occasional roosting. Due to the relatively high elevation (5,851 feet) and annual precipitation, a mountain meadow effect was created by the strip spray. Unfortunately, most sage grouse habitat in Idaho occurs at low elevation with half (or less) the annual precipitation of the study area. Brush eradication in such areas is usually detrimental to sage grouse populations (Braun et al. 1977).

Klebenow (1970) found low sagebrush coverage due to spraying reduced the brood carrying capacity of an area in Idaho. He noted that old sprayed areas that had sage and forb regrowth since the original treatment were being used by broods, but that more recently sprayed areas with high sagebrush kills were not being utilized. Trueblood (1954) noted that sage grouse made use of the reseeded areas for morning and evening feeding activities in Utah. However, he concluded that suitability of reseeded cover for sage grouse was closely linked to seasonal precipitation and forb production.

Effects on Winter Habitat

Pyrah (1972) working with dropping counts, reported that sage grouse winter use of an area in Montana was proportional to the severity of treatment. Those treatments doing the least damage to sagebrush affected

sage grouse use the least and the duration of the adverse effect was shortest. He determined that strip partial kill, block partial kill, mechanical treatments, and total kill spray (in that order) were increasingly detrimental to sage grouse. Virtually no winter use occurred in total sagebrush kill areas. In Wyoming (Higby 1969) 12,000 acres were treated and in excess of 80% of the sagebrush cover was destroyed during a five-year period resulting in the destruction of habitat previously supporting approximately 1,000 wintering birds. Practically no winter use of the area has occurred since the sagebrush was killed.

Summary of Sagebrush Treatment Impacts

Considering the needs of the birds and the effects of herbicide treatment, the *possibility of conflict is great.* But whether spraying is beneficial or harmful will be determined by the individual situation. Excessive removal of food and cover is not tolerable when the habitat is crucial for broods. However, not all sagebrush-grassland is brood habitat and not all brood habitat is in the most desirable condition. Cover is most significant for nesting but not all sagebrush is nesting cover nor in the best of condition for nesting. Some sagebrush control may be desirable in cases where the range has degraded to the point where it is unsuitable because of too great amounts of cover or high shrub density crowding out food plants.

Guidelines for improvement of depleted sagebrush rangelands must recognize that *different sagebrush-grass rangelands may serve different purposes for sage grouse* (Klebenow 1972). Habitat managers must recognize that some habitats are *significant and high quality for sage grouse and should be entirely excluded from vegetal control programs* (Christensen 1968). These include areas used for breeding and nesting, wintering ranges, cover adjacent to water courses or springs, upland meadows and other summering areas. Big sagebrush and other shrubs should be removed only to the extent of the original meadow boundary.

Of medium importance are extensive sagebrush covered areas (usually in a valley floor) which are not used for strutting, nesting, or as summer range and generally receive a low amount of sage grouse use. In these cases, *control practices are allowed*, but we recommend removal of sagebrush in irregular patterns, leaving islands of brush. No large blocks should be treated.

Nevada and other states have many areas which are unoccupied by sage grouse, usually in valley floors or on surrounding slopes which often emcompass the salt desert shrub vegetation type. In such areas there is no objection to control practices so far as sage grouse habitat is concerned (Klebenow 1972).

Effects of Livestock Grazing

The effects of livestock grazing on sage grouse habitat are primarily of 3 types: (1) changes in vegetation composition, density, and structure, (2) disturbance of nesting hens and possible nest trampling, and (3) removal of brood cover in meadows.

The presence of succulent forbs in brood areas is highly important to young sage grouse. While the dependence of *newly-hatched chicks* on insects is high, by the time they are 4 to 8 weeks old their diet consists of about 75% forbs and 15% sagebrush leaves (Savage 1969). Therefore, a rapid removal of forbs by livestock on spring and summer ranges *may* have a substantial adverse impact on young sage grouse, especially where forbs are already scarce in the composition. By May, adult sage grouse also shift from diets dominated by sagebrush to diets dominated by forbs.

Many sagebrush ranges on public lands are grazed by domestic sheep in winter. Others are used by cattle either in summer or winter. In some areas sagebrush has been grazed so heavily in winter for several years that the brush has been almost killed. If such use occurs on important sage grouse wintering areas, sage grouse may have difficulty in obtaining sufficient forage for their needs, especially during severe winters. The degree of impact then varies with the intensity of grazing and the severity of the winter.

During his research Patterson (1952) reported that on two occasions bands of sheep caused birds to flush and simultaneously to flip eggs out of their nests. Sheep subsequently stepped on these eggs, destroying them, and desertion occurred in both cases. *No instances* were noted of sheep breaking up sage grouse nests by stepping *into* them. In a few cases, nests were placed on open ground *between shrubs* and could have been destroyed by livestock activities, but *no destruction* of this nature *was recorded*. There was *no indication* that livestock is a serious factor in nest destruction, although *nest desertion from livestock activities was of frequent occurrence under certain conditions*. Desertion was most prevalent in the vicinity of sheep bedgrounds. Bands of from 2,000 to 3,000 sheep were serious disturbances to nesting activities. Most nests found deserted were either unincubated or in the *early stages* of incubation. Patterson (1952) noted that it was significant that several thousand sheep began moving into his study area en route to their summer ranges *coincident with the period of nest desertion*. However, he reported that *nest desertion seldom occurred after incubation was well underway*. During incubation, several birds were observed to be flushed from nests by sheep with no evidence of desertion.

Effects of Fire on Sage Grouse Habitat

Fire may be used as a tool to achieve one of the sage grouse habitat management objectives i.e., a diverse habitat providing for all the needs of sage grouse. Schlatterer (1960) and Dalke et al. (1963) mentioned how an area that was unintentionally burned created a strutting ground that birds were quick to occupy. These openings are necessary for the birds and small burned areas, 1 to 10 acres in size, at the elevations utilized for breeding may be beneficial in homogeneous sagebrush types (Klebenow 1972).

Nesting occurs in light to moderate sagebrush density. Where sage is dense, habitat improvements could be achieved by moderate burning coupled with grazing management to get the *mosaic* of shrub plus grass and forb cover the sage grouse appear to prefer. Repeated burning could be adverse in this case, as would large, hot fires where an excessive amount of cover is removed. Griner (1939) noted where burning caused a decline in sage grouse use in Utah. Pyrah (1963) also alluded that fire has been a problem in some areas he studied. Where cover is already limited, fire has been a problem.

Fire can be a useful tool where sagebrush rangelands interspersed with meadows and other grassy openings have been converted to monotonous sagebrush-covered hills and valleys. Burning small areas to achieve a *mosaic of food and cover areas* should produce a pattern more suitable for these birds. Different stages of successional growth would be desirable in order to produce the greatest variety of forb food items. A diversity of habitat types, both in terms of food and cover, should be an objective. Fire creates openings and Blaisdell (1953) reported higher yields of forbs on sites that had been intentionally burned.

In wintering habitats, there is little place for fire. Retention of sagebrush is essential on winter ranges. Even tall, decadent sagebrush, not useful for nesting or brooding, may be important during severe winters when most other sagebrush could be covered by snow.

Effects of Human Disturbance on Sage Grouse Activities

Human activities in sage grouse habitat will cause varying degrees of disturbance. Such activities will vary from occasional harassment, to disruption of the nesting cycle, to elimination of use of critical winter ranges. Hunting and poaching will not be discussed here as they are not habitat-related factors.

Undue human disturbance on sage grouse strutting grounds *could cause* reduction in mating, and some reduction in total production. Grouse usually fly from the strutting ground and do not return again that morning

if flushed by humans. Some strutting grounds are well known to the public and are visited frequently by photographers and other interested persons to watch the annual courtship rituals. Such activities of the general public may need to be curtailed if they disrupt mating. Grouse are tolerant of automobiles and may be watched from fairly close range if the observers do not leave their vehicles. However, the minute a person leaves the vehicle and begins to walk across the area, the grouse become alarmed and generally take flight, not to return again that morning. Fortunately, the mating season is fairly long (up to 2 months) so it is *unlikely* that any *receptive hens* will not be mated.

Off-road vehicles will occasionally run over a nest but the amount of loss from this activity is *probably insignificant*. However, organized motorcycle or 4-wheel drive races across sage grouse nesting habitat could cause substantial loss of production, either from direct nest destruction, or from nest abandonment during egg-laying. No such races should be permitted in grouse habitat.

The effects of sheep and sheepherding activities on winter habitat are not well known, but are probably related to the *total amount* of sagebrush present on a particular winter range, its *availability* to grouse, and the *degree of browsing* by sheep. Excessive utilization by sheep should not be permitted. However, if snow accumulates to the extent that most of the sagebrush becomes covered and unavailable to grouse, sheep browsing may be *beneficial* to the birds by uncovering browse as they feed.

Decisions to control and/or eradicate sagebrush should not be made until full consideration of all land use values has been given and it has been determined that sagebrush control is necessary to achieve specific high priority management goals.

The following recommendations for management of sage grouse habitat are those that are considered essential to maintain crucial habitats. The suggested procedures are primarily those that have been approved by the Western Association of Fish and Game Commissioners and that have been formulated to minimize the detrimental effects of sagebrush control on the sage grouse resource (Braun et al. 1977).

Project Coordination

1. BLM should notify the state wildlife agency of each specific proposal to control sagebrush or other vegetation a minimum of 2 years in advance of treatment. In situations where it is not possible to provide such notice, the state wildlife agency should be notified as soon as the project is proposed. An adequate amount of lead time is necessary to properly evaluate control projects during *all seasons of the year*.

2. BLM should provide the state wildlife agency with detailed maps on which the proposed areas to be treated are located and defined along with detailed plans as to the type of treatment and expected results.

3. The state wildlife agency will be expected to plot sage grouse use areas on the maps furnished, to include: (1) strutting grounds (leks), (2) nesting areas, (3) meadows and summer range or brood areas, and (4) wintering sites.

4. Representatives of BLM and the state wildlife agency should meet on the proposed project area for an on-the-ground inspection of the proposal following completion of the maps.

5. No sagebrush should be treated or removed until a comprehensive multiple-use management plan (MFP) has been formulated for the area.

6. Project plans for sagebrush control should include provisions for long-term quantitative and qualitative measurements of vegetation before and after control to acquire data on the effects of wildlife habitat, and to ascertain whether the objectives of the project were accomplished. The BLM should bear the responsibility for evaluation of the project as it relates to changes in habitat, while the state wildlife agency should assume

the responsibility of measuring the effects of the project on the sage grouse. The results should then be exchanged and a joint evaluation accomplished.

Project Implementation

1. No control work should be considered where live sagebrush cover is less than 20%, or on steep (20% or more gradient) upper slopes with skeletal soils where big sagebrush (*Artemisia tridentata*) is 12 inches (30 cm) or less in height.

2. The breeding complex (strutting grounds, or leks, and nesting areas) should be considered as all lands within a 2 mile (3 km) radius of an occupied lek (in some situations, depending on the quality of the nesting habitat, this radius may well exceed 2 miles). Control of vegetation within the breeding complex should not be undertaken within 2 miles of leks, or on nesting and brood areas. On-site investigations by the Bureau and state wildlife agency personnel is essential in determining inviolate areas. Areas to be protected from treatment must be clearly defined on the project maps.

3. No control of sagebrush should be considered in any area known to have supported important wintering concentrations of sage grouse within the past 10 years.

4. No control should be attempted along streams, meadows, or secondary drainages (dry and intermittent). A 100-yard strip (minimum) of living sage should be retained on each edge of meadows and drainages. During the on-site inspection BLM and state wildlife agency personnel will assess the desirability of increasing or decreasing the width of untreated strips in specific areas.

5. When sagebrush control is found to be unavoidable in sage grouse range, all treatment measures should be applied in irregular patterns using topography and other ecological considerations to minimize adverse effects to the sage grouse resource. Widths of treated and untreated areas can vary for the convenience of application technique; except, treated areas should not be wider than 100 feet (30 m) and untreated areas will be at least as wide as treated areas. The untreated areas should not be treated until food and cover plants in the treated areas attain comparable composition to that of the untreated areas.

6. Where possible, spraying should be done with a helicopter or ground equipment. No spraying should be done when wind velocity exceeds 6 or 7 miles per hour (10 km/hr).

7. Whenever possible, complete kill or removal of sagebrush in treated areas should be avoided. Partial kill or removal of sagebrush may enhance the area for livestock, prevent loss of all snow cover in winter and allow for some use of the disturbed area by sage grouse.

8. Sagebrush treatment should be confined to only the most productive sites where the greatest favorable returns can be expected.

9. When exceptions to the above guidelines occur, sound biological judgment should be used to arrive at appropriate recommendations. Each individual situation should be carefully investigated and analyzed before arriving at the final decision.

Livestock Management

1. Every effort should be made to delay sheep bands from utilizing known sage grouse nesting areas until about the first week in June, or until young sage grouse have hatched in the particular locality. Domestic sheep are known to have caused considerable nest abandonment around bedgrounds, in trailing areas, and during normal feeding (Patterson 1952).

2. Cattle are generally not considered to cause nest desertion or nest trampling.

3. Livestock should not be permitted to heavily use known important sage grouse wintering areas. Heavy utilization may leave inadequate forage for sage grouse, but will depend on size of the wintering area and amount of sagebrush, depth of snow, and severity of the winter.

4. Grazing and browsing by livestock is an accepted use of sagebrush range. However, this use should be carefully controlled to encourage maximum forage productivity and to prevent range deterioration.

Coal and Minerals Management

1. Large tracts of sagebrush range in Wyoming, Colorado, and Montana are underlain by coal deposits. Extensive strip mining of some deposits is now underway and it appears that strip mining will be a major disturbance in sagebrush areas for at least the next 40 years. Present effects of increased energy exploitation on bird life of the sagebrush type are not known. It is anticipated that most effects will be detrimental, especially those related to disposition of overburden, waste products, and road development. Of considerable importance to the avifauna in areas surrounding energy extraction sites is the unknown but assumed detrimental effects of increased human populations living and working in the area.

2. *Where possible*, land managers should delay approval of mining on *key areas* that seem to be *most critical* to the survival of local sage grouse populations. Sometimes this can be done by requesting coal mining companies to avoid initial mining activities in certain specified habitats. In some cases the movement of a mining operation by only one-half mile will be acceptable to a mining company and may prolong the life of sage grouse (and other sensitive wildlife) populations by several years.

Fire Management

1. Where fire is used as a habitat management tool, it should be used in such manner as to result in a mosaic pattern of shrubs and open areas, with openings being from 1 to 10 acres in size.

2. Large, hot fires may remove an excessive amount of cover or may sterilize the soil and should be avoided.

3. Burning within an area should be done on a rotational basis, burning different patches every few years, possibly with as long as 20 years between burning treatments on each site. This will produce a diversity of habitat within the general area.

4. Do not burn winter sagebrush habitats that have been identified as important wintering sites. In such areas the grouse are dependent on the leaves of sagebrush, not the potential development of grass and forbs in the understory or interspersed openings.

5. Fire is an inexpensive tool that may be used for habitat manipulation but all projects *must* be carefully planned and supervised.

6. Use of fire should be avoided during the spring and summer when it could destroy many small nesting birds, small mammals, snakes, etc., as well as young sage grouse.

7. Fire is a natural element that has occurred on deserts and prairies for eons of time and to which most animals have become adapted over the centuries. Many of our present native environments are really disclimaxes that have resulted from natural fires. When properly used and managed, it can be successfully utilized in perpetuating the kinds of habitats that are essential to many different forms of wildlife.

Visitor/ORV Management

1. Occasional nest abandonment or destruction will be caused by vandals, unthinking persons, or by accident incidental to human recreational activities on the public lands. Accompanying pets may also find and destroy an occasional nest. The amount of production lost through such activities will probably not be significant to most sage grouse populations.

2. Of primary concern on public lands is the authorization of ORV races across habitats that are critical to one form of wildlife or another. BLM managers must continue to evaluate all potential impacts on the environment during such events and, where deemed in the best public interest, to either stipulate that all such events must be conducted after the reproductive period, or else be conducted in an area where no loss to habitats of sensitive or otherwise important wildlife populations will occur.

3. Organizers of ORV events on public lands must be warned of the potential for fire caused by hot mufflers and tail pipes or by sparks or hot exhaust in brushy or grassy areas. Close supervision of organized events is essential to preclude unexpected fires from destroying important areas of habitat.

Water Management

As discussed in the section on water (p. 11), sage grouse normally select areas near water for rearing broods and spending the summers. This suggests that habitat can be improved for these birds by providing water where it is not available in otherwise suitable habitat, or by managing livestock waters so that water can be made available to grouse throughout the summer and fall.

In BLM Technical Note No. 305 by Lanny O. Wilson entitled *GUIDELINES AND RECOMMENDATIONS FOR DESIGN AND MODIFICATION OF LIVESTOCK WATERING DEVELOPMENTS TO FACILITATE SAFE USE BY WILDLIFE* several designs are discussed that could be utilized for watering by sage grouse. Habitat for sage grouse and many other species of wildlife living in the same area would be improved if some type of free water could be provided for their use every three or four miles across sagebrush-covered valleys and foothills. It would probably be preferable to provide such water at ground level, such as from a water tank overflow, or by constructing small rocky pools with concrete bottoms, but any water that could be reached would be utilized. All water troughs or tanks in sage grouse habitat should be provided with ramps such as those described in Tech Note 305.

Fig. 8. Many kinds of birds, as well as deer and other animals, sometimes encounter difficulties with barbed wire fences. The author has photographs of long-eared owls, short-eared owls, burrowing owls, and prairie falcons that are entangled in barbed wire, apparently killed while traversing low over the countryside searching for prey. At the site shown, which was near Randolph, Utah, the local conservation officer counted approximately 36 carcasses of sage grouse along 2 miles of fence during 3 winter months of the first winter the fence was in place. Steel posts were used in the fence, placed about 2 rods apart with a stay in between, making the fence fairly inconspicuous. Feathers on the wires are those of sage grouse (Thomas, 1971, pers. comm.).

LITERATURE CITED

Autenrieth, R. E. 1969. Impact of strip spray on vegetation and sage grouse use on summer habitat. Proc. Biennial Western States Sage Grouse Workshop. 6:147-157.

Bean, R. 1941. Live history studies of the sage grouse (*Centrocercus urophasianus*) in Clark County, Idaho. M.S. Thesis. Utah State Univ., Logan. 44 pp.

Beck, T. D. I. and C. E. Braun. 1978. Weights of Colorado sage grouse. Condor, 80:241-243.

Blaisdell, J. P. 1953. Ecological effects of planned burning of sagebrush-grass range on the upper Snake River Plains. U.S. Dept. Agric. Tech. Bull. No. 1075. 39 pp.

Braun, C. E., T. Britt, and R. O. Wallestad. 1977. Guidelines for maintenance of sage grouse habitats. Wildl. Soc. Bull. 5:3, pp. 99-106.

Bureau of Land Management. 1970. Sage grouse Technical Supplement 6601-3, MR 6601 -- Species life history and habitat requirements. Denver Service Center, Denver, Colo. 12 pp.

Carhart, A. H. 1941. Sage grouse survey in Colorado. Colorado Game and Fish Comm.; Fed. Aid Proj. 4-R, Survey of 1941. 3. 31 pp.

Cary, M. 1911. A biological survey of Colorado. No. Am. Fauna. No. 33. 256 pp.

Christensen, G. D. 1968. Guidelines for sagebrush control practices in sage grouse habitat. Nevada Fish & Game Comm. Policy No. 18. 7 pp.

Crawford, J. E. 1960. The movements, productivity, and management of sage grouse in Clark and Fremont Counties, Idaho. M.S. Thesis. Univ. Idaho, Moscow. 85 pp.

Dalke, P. D., D. B. Pyrah, D. C. Stanton, J. E. Crawford, and F. Schlatterer. 1960. Seasonal movements and breeding behavior of sage grouse in Idaho. Trans. No. Am. Wildl. Conf., 25:396-407.

_____, D. B. Pyrah, D. C. Stanton, J. E. Crawford, and E. F. Schlatterer. 1963. Ecology, productivity, and management of sage grouse in Idaho. J. Wildl. Manage. 27:810-841.

Eng, R. L. 1952. Population trends and breeding potential studies (sage grouse brood studies). Montana Fish and Game Comm., Wildlife Restoration Div. Quart. Prog. Rep. 3(4):56-62.

_____, and P. Schladweiler. 1972. Sage grouse winter movements and habitat use in central Montana. J. Wildl. Manage. 36:141-146.

Enyeart, G. W. 1956. Responses of sage grouse to grass reseeding in the Pines Area, Garfield County, Utah. M.S. Thesis, Utah State Univ., Logan. 55 pp.

Gill, R. B. 1965. Distribution and abundance of a population of sage grouse in North Park, Colorado. M.S. Thesis, Colorado State Univ., Fort Collins. 187 pp.

Girard, G. L. 1937. Life history, habitats, and food of the sage grouse, *Centrocercus urophasianus* Bonaparte. Univ. Wyo. Publ., 3:1-56.

Gray, G. M. 1967. An ecological study of sage grouse broods with reference to nesting, movements, food habits and sagebrush strip-spraying in the Medicine Lodge Drainage, Clark County, Idaho. M.S. Thesis. Univ. Idaho, Moscow. 200 pp.

Griner, L. A. 1939. A study of the sage grouse (*Centrocercus urophasianus*) with special reference to life history, habitat requirements, and numbers and distribution. M.S. Thesis. Utah State Univ., Logan. 111 pp.

Higby, L. W. 1969. A summary of the Longs Creek sagebrush control project. Proc. Biennial Western States Sage Grouse Workshop 6:164-168.

Keller, R. J., H. R. Shepherd, and R. N. Randall. 1941. Survey of 1941: North Park, Jackson County, Moffat County, including cooperative data on previous seasons. Colorado Game and Fish Dept., Sage Grouse Survey 4. 31 pp.

Klebenow, D. A. 1969. Sage grouse nesting and brood habitat in Idaho. J. Wildl. Manage. 33(3):649-661.

_____. 1970. Sage grouse versus sagebrush control in Idaho. J. Range Manage. 23:396-400.

_____. 1972. The habitat requirements of sage grouse and the role of fire in management. Proceedings Annual Tall Timbers Fire Ecology Conf. pp. 305-315.

Klebenow, D. A., and G. M. Gray. 1969. Food habits of juvenile sage grouse. J. Range Manage. 21(2):80-83.

Martin, N. S. 1970. Sagebrush control related to habitat and sage grouse occurrence. J. Wildl. Manage. 34:313-320.

Martin, A. C., H. S. Zim, and A. L. Nelson. 1951. American wildlife and plants. McGraw-Hill Book Co., Inc., New York. 500 pp.

Miles, W. H. 1946. Clearing and reseeding sagebrush lands. U.S. Soil Cons. Serv. Regional Bull. No. 100, Range Manage. Series No. 10, Albuquerque. 16 pp.

Patterson, R. L. 1952. The sage grouse in Wyoming. Sage Books, Inc., Denver. 341 pp.

Peterson, J. G. 1970. The food habits and summer distribution of juvenile sage grouse in central Montana. J. Wildl. Manage. 34:147-155.

Price, R. 1948. Conservation problems and practices. Pages 569-574 in Grass---The Yearbook of Agriculture. U.S. Dept. Agric.

Pyrah, D. B. 1954. A preliminary study toward sage grouse management in Clark and Fremont Counties based on seasonal movements. M.S. Thesis. Univ. Idaho, Moscow. 90 pp.

_____. 1963. Sage grouse investigations. Idaho Fish and Game Dept. Job Compl. Rept., Proj. W-125-R-2. 71 pp.

_____. 1972. Effects of chemical and mechanical sagebrush control on sage grouse. Subject: Dropping counts. Pages 16-25 in Ecological effects of chemical and mechanical sagebrush control. Montana Fish and Game Dept., Job Prog. Rept. W-105-R-6. 79 pp.

Rogers, G. E. 1964. Sage grouse investigations in Colorado. Colorado Dept. Game, Fish and Parks. Tech. Publ. 16. 132 pp.

Savage, D. E. 1968. The relationship of sage grouse to upland meadows in Nevada. M.S. Thesis. Univ. Nevada, Reno. 172 pp.

_____. 1969. Relation of sage grouse to upland meadows in Nevada. Job Prog. Rept. W-39-R-9. Nevada Dept. of Fish and Game. 101 pp.

Schlatterer, E. F. 1960. Productivity and movements of a population of sage grouse in southeastern Idaho. M.S. Thesis. Univ. Idaho, Moscow. 87 pp.

Schneegas, E. R. 1967. Sage grouse and sagebrush control. Proc. No. Am. Wildl. and Natur. Res. Conf.

Trueblood, R. W. 1954. The effect of grass reseeding in sagebrush lands on sage grouse populations. M.S. Thesis. Utah State Univ., Logan. 77 pp.

Vale, T. R. 1974. Sagebrush conversion projects: An element of contemporary environmental change in the western United States. Biol. Conserv. 6:274-284.

Wallestad, R. O. 1971. Summer movements and habitat use by sage grouse broods in central Montana. J. Wildl. Manage. 35:129-136.

_____. 1975. Life history and habitat requirements of sage grouse in central Montana. Montana Fish and Game Dept. Tech. Bull. 66 pp.

_____, and D. Pyrah. 1974. Movement and nesting of sage grouse hens in central Montana. J. Wildl. Manage. 38:630-633.

_____, and C. R. Watts. 1973. Factors affecting annual sage grouse productivity in central Montana. Montana Fish and Game Dept. Job Prog. Rept., Proj. W-120-R-3. 23 pp.

_____, and P. Schladweiler. 1974. Breeding season movements and habitat selection of male sage grouse. J. Wildl. Manage. 38:634-637.

☆U.S. GOVERNMENT PRINTING OFFICE: 1979-0-679-442/412